

Impact of Solar Array Designs on High Voltage Operation

Henry W. Brandhorst, Jr.

Space Research Institute, Auburn University, AL

Dale Ferguson

NASA Marshall Space Flight Center, Huntsville, AL

Mike Piszczor

NASA Glenn Research Center, Cleveland, OH

Mark O'Neill

ENTECH, Inc., Keller TX

As power levels of advanced spacecraft climb above 25 kW, higher solar array operating voltages become attractive. Even in today's satellites, operating spacecraft buses at 100 V and above has led to arcing in GEO communications satellites, so the issue of spacecraft charging and solar array arcing remains a design problem. In addition, micrometeoroid impacts on all of these arrays can also lead to arcing if the spacecraft is at an elevated potential. For example, tests on space station hardware disclosed arcing at 75V on anodized Al structures that were struck with hypervelocity particles in Low Earth Orbit (LEO) plasmas. Thus an understanding of these effects is necessary to design reliable high voltage solar arrays of the future, especially in light of the Vision for Space Exploration of NASA.

In the future, large GEO communication satellites, lunar bases, solar electric propulsion missions, high power communication systems around Mars can lead to power levels well above 100 kW. As noted above, it will be essential to increase operating voltages of the solar arrays well above 80 V to keep the mass of cabling needed to carry the high currents to an acceptable level. Thus, the purpose of this paper is to discuss various solar array approaches, to discuss the results of testing them at high voltages, in the presence of simulated space plasma and under hypervelocity impact

Three different types of arrays will be considered. One will be a planar array using thin film cells, the second will use planar single or multijunction cells and the last will use the Stretched Lens Array (SLA – 8-fold concentration). Each of these has different approaches for protection from the space environment. The thin film cell-based arrays have minimal covering due to their inherent radiation tolerance, conventional GaAs and multijunction cells have the traditional cerium-doped microsheet glasses (of appropriate thickness) that are usually attached with Dow Corning DC 93-500 silicone adhesive. In practice, these cover glasses and adhesive do not cover the cell edges. Finally, in the SLA, the entire cell and cell edges are fully encapsulated by a cover glass that overhangs the cell perimeter and the silicone adhesive covers the cell edges providing a sealed environment.

These three types of blanket technology have been tested at GRC and Auburn. The results of these tests will be described. For example, 15 modules composed of four state-of-the-art 2x4 cm GaAs solar cells with 150 μ m cover glasses connected in two-

cell series strings were tested at high voltage, in plasma under hypervelocity impact. A picture of one of the modules is shown in figure 1. These were prepared by standard industry practice from a major supplier and had efficiencies above 18%. The test results and other fabrication factors that influenced the tests will be presented. In addition, results for SLA segments tested under the same conditions will be presented. Testing of thin film blankets at GRC will also be presented.

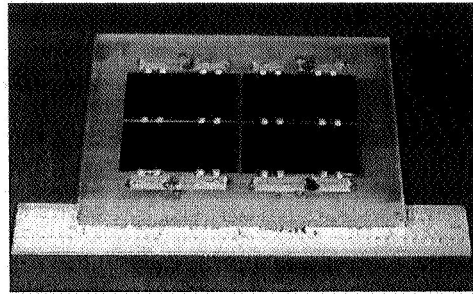


Figure 1: Typical GaAs Solar Cell Module

These results will show significant differences in resistance to arcing that are directly related to array design and manufacturing procedures. Finally, the approaches for mitigating the problems uncovered by these tests will be described. These will lay the foundation for future higher voltage array operation, even including voltages above 300-600 V for direct drive SEP applications.